REMARKS

In the Office Action mailed November 14, 2002, claims 1-20 were rejected under 35 U.S.C. 112, second paragraph. Claims 1-4, 11 and 18-19 were rejected under 35 U.S.C. 102(b) as being anticipated by Bederson et al. (United States patent No. 5,204,573). Claims 5-10 and 12-17 were rejected under 35 U.S.C. 103(a) over Bederson in view of Sauvage (Acc. Chem. Res. 1998, 31, 611-619).

The amendments

Claim 1 has been amended to clarify that the rotor portion is connected to the axle of the molecular dipolar rotor. This amendment is supported by the specification as filed, including the structures shown on pages 5 through 18. The abbreviation "D" in claim 3 has been replaced with the term "debye" for clarification. Also, claim 3 has been amended for clarification by adding the terms "of the rotor portion". The added terms appears in claim 2, from which claim 3 depends. Claim 11 has been amended to clarify that the axle is a transition metal atom. The amendment to claim 11 is supported by the specification as filed, including page 3, line 8. Claim 20 has been amended to clarify the motion of the dipolar rotor. The motion of the dipolar rotor is described in the specification on page 23, line 26 through page 25, line 22, for example. All amendments are supported by the specification and claims as filed and no new matter is added.

35 U.S.C. 112, second paragraph rejections

Claims 1 and 2 were rejected for the use of the word "substantially". The Office Action stated the term "substantially" in claims 1 and 2 was a relative term which rendered the claims indefinite. In response, it is believed the term "substantially" when referring to the chemical structures in the claims is definite. Claim 1 describes a molecular dipolar rotor comprising a base, an axle connected to the base and oriented substantially perpendicular to the base, and a rotor portion having an electric dipole moment. Examples of bases and axles are given in the specification, for example the structures on page 5. As one example, in structures

1 and 1A, a silicon atom with three chlorine atoms is the base, and either a carbon-carbon single bond or triple bond is the axle. As shown in the structures, the axle is connected to the base and is oriented substantially perpendicular to the base. Chemical bonds do not form precisely perpendicular (i.e., 90 degree) bonds. Rather, the exact angle is determined by the equilibrium energy position of the atoms from which the structures are made. The atoms will assume the configuration of lowest energy (see Exhibit A, pages 20-21 of March, Advanced Organic Chemistry, 3d Edition, 1985, John Wiley & Sons). The specification on page 3, lines 10 and 11 describes the axle as rigid enough to prevent undesired motions that interfere with the desired operation. According to the court in Andrew Corp. v. Gabriel Electronics, 847 F.2d 819, 6 USPQ2d 2010, 2012 (Fed. Cir. 1988), cited in MPEP 2173.05(b)(D), the term "substantially" is not indefinite if the term serves "reasonably to describe the claimed subject matter to those of skill in the field of the invention." One of ordinary skill in the art recognizes this limitation on describing actual chemical structures and would be apprised of the scope of the invention.

Claim 3 was rejected for insufficient antecedent basis for the use of the term "2D". The term 2D is an abbreviation for 2 debye. Claim 3 has been amended to replace the abbreviation "D" with the word "debye" for clarification. Also, the terms "of the rotor portion" have been added for clarification. It is believed all terms of claim 3 include sufficient antecedent basis.

Claim 3 was rejected for the term "about". In response, the term "about" has been removed from the claim.

Claim 20 was rejected for omitting essential structural cooperative relationships of elements. The Office Action stated the omitted structural cooperative relationships are: "how the rotor produces electric current when it rotates upon excitation by an alternating electric field, which was created by electric current applied to the coils." It is unclear what "coils" are referred to in

the Office Action and it is assumed this is a typographical error. Claim 20 has been amended to clarify the motion of the dipolar rotor. The motion of the dipolar rotor is described in the specification on page 23, line 26 through page 25, line 22, for example. The charge induced is described by the equations on page 15, line 26 through page 16, line 9. It is believed this clarifies the operation of the elements.

In view of the above arguments and amendments, it is believed all 35 U.S.C. 112, second paragraph rejections are overcome. Reconsideration and withdrawal of all 35 U.S.C. 112, second paragraph rejections is respectfully requested.

35 U.S.C. 102(b) rejection

Claims 1-4, 11 and 18-19 were rejected under 35 U.S.C. 102(b) as being anticipated by U.S. Patent No. 5,204,573 to Bederson et al. The Office Action states:

> Bederson et al. clearly teaches the construction of a two-dimensional pointing motor comprising:
> a base (15);
> a transition metal axle (13) connected to said base and oriented substantially perpendicular to said base;
> a rotor portion (12) having an electric dipole moment greater than about 2D and substantially in the plane perpendicular to the axle;
> a bearing (column 4, lines 22-23) connecting the axle and the rotor portion; and
> an excitation (motor drive of Figure 9, electrical force) source that can induce movement of the rotor portion of the dipolar rotor.

The Office Action stated with regards to claim 20, "the motor disclosed by Bederson et al. will produce electric current in the coils (A, B, C) if magnets (12) are rotated by creating an alternating magnetic field. This is just using the motor as a generator, or reversing the electromagnetic cycle to obtain electric current from moving magnets."

As noted in the Office Action, the Bederson patent does teach the construction of a two dimensional pointing motor. However, the present invention is not directed to a two-dimensional pointing motor. It is important to note that the present invention is directed to a molecular dipolar rotor, in other words, a molecular-scale arrangement of atoms on a surface (page 1, lines 11-12). The Bederson patent describes a physical macroscopic motor which moves in two dimensions. The Bederson motor moves by electromagnetic fields created by a permanent magnet and three orthogonal coils. Quoting column 2, lines 19-25, "by passing different currents through the three coils, an electromagnetic field is created whose orientation is dependent on the ratio of the currents in the three coils. A force will then act on the permanent magnet and the coil to align the two fields into the position of lowest potential energy." The motor of Bederson et al. is a mechanical electric motor, not a molecular dipolar rotor, as described in the present invention. This is a critical difference between the present invention and Bederson.

The terms "base" "axle" "rotor" "bearing" are used in the present invention to describe aspects of the molecular dipolar rotor. These terms are <u>not</u> macroscopic parts that carry the same name and can be picked up and welded together—rather, as described in the specification of the present invention, these terms represent atoms combined in a chemical reaction.

The motor of Bederson is about a 1.5 inch cube (column 2, line 43). By comparison, the molecular dipolar rotor of the present invention is a small collection of atoms on a molecular scale.

In addition, even if the molecular scale differences are ignored, there are clear differences between the mechanical motor of Bederson and the molecular dipolar rotor of the present invention. The base of the present invention is defined as "a structure that is capable of attaching to an axle on one side and to a surface on the other side. Bases may comprise a variety of structures. Bases may include

one or more aromatic or nonaromatic rings, for example four, five or six membered ring structures; single atoms such as Si or C; and other structures as known in the art." (page 2, line 12-15). "Attaching" as used in the present invention means a chemical bond (see figures in specification) not a mechanical attachment such as a weld. The Office Action compares the base of the present invention to structure 15 of the Figures of Bederson, which is a macroscopic structure onto which a gimbal and magnets are mounted (column 4, lines 19-20). These structures are not analogous.

In the present invention, the axle is connected to the base and oriented substantially perpendicular to the base (claim 1). The axle in the present invention is described as "a triple bond, a single bond, a metal atom such as a transition metal" for example (page 3, lines 7-11). The Office Action indicates axle (13) of the Bederson patent corresponds to this molecular axle. The axles in Bederson are macroscopic structures (parts), such as those found in a car, on which the gimbal moves (column 4, lines 20-23). There are no molecular structures such as a single bond, a triple bond or metal atoms described in Bederson. In addition, the Office Action indicates that the axle (13) can be a transition metal. It is unclear where in Bederson this description is found and further guidance is respectfully requested. However, even if the axle could be made from a transition metal, the meaning of "axle" is different. A transition metal axle of the present invention is described as a transition metal atom (page 3, line 8), not a rod formed from a metal, as the term "axle" is used in Bederson.

In the present invention, the rotor portion is the portion of the molecular dipolar rotor (see specification, page 3, line 22 through page 4, line 10, for example) that has an electric dipole moment that causes rotation of the rotor portion in an alternating electric field or upon application of another suitable stimulus (page 3, lines 25-27). The rotor portion of the present invention is not shown in Bederson. The Office Action described the permanent magnets of Bederson as "a rotor portion (12) having an electric dipole moment greater than

about 2D and substantially in the plane perpendicular to the axle" and continues with "an excitation (motor drive of Figure 9, electrical force) source that can induce movement of the rotor portion of the dipolar rotor." Structure 12 of Bederson is a permanent magnet. The permanent magnet of Bederson does not rotate at all, and certainly not upon application of an alternating or rotating electric field or other suitable stimulus. In fact, no portion of the structure in Bederson rotates upon application an alternating or rotating electric field or other suitable stimulus. Therefore, the motor of Bederson does not, by definition, anticipate the rotor of the present invention.

The bearing of the present invention is described on page 2, lines 7-8, for example, as a bond, such as a metal-to-π-face bond. The Office Action states column 4, lines 22-23 of Bederson corresponds to this structure. Column 4, lines 22-23 of Bederson describes bearings on which axles 13 and 14 are mounted. These bearings are designed to allow movement of the gimbal along the axles and are not bonds, such as a metal-to-π-face bond.

The excitation source of the present invention is described in the specification on page 10, line 24 through page 11, line 2 and is a force that drives the rotor portion to move or oscillate. The Office Action states the motor drive in Figure 9 of Bederson corresponds to this excitation source. The motor drive in Figure 9 of Bederson "amplifies the PWM (pulse-width modulation) signal from the microcontroller to supply enough current to drive the motor" (column 10, lines 29-32). There is no such device in the present invention.

The Office Action states "with regards to claim 20, the motor disclosed by Bederson et al. will produce electric current in the coils (A, B, C) if magnets (12) are rotated by creating an alternating magnetic field. This is just using the motor as a generator, or reversing the electromagnetic cycle to obtain electric current from moving magnets." It is not seen where Bederson describes rotating the magnets (12). Further clarification on this point is requested. For clarity, claim

20 has been amended to specify the rotor portion of the dipolar rotor rotates upon excitation by an alternating or rotating electric field, producing electric current by the alternating motion of the electric dipole of the rotor portion of said dipolar rotor.

In view of the above arguments, it is submitted that claims 1-4, 11 and 18-19 are not anticipated by Bederson. Reconsideration and withdrawal of the rejection is respectfully requested.

35 U.S.C. 103(a) rejection

Claims 5-10, 12-17 were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,204,573 to Bederson et al. in view of "Transition Metal-Containing Rotaxanes and Catenanes in Motion" (Sauvage). The Office Action states:

> Sauvage teach [sic] the use of transition metal-containing rotaxanes and catenanes for the purpose of constructing molecular machines and motors having:
> metal-to-n-face bond bearings;
> covalently attached bases, which can be carbon or silicon atoms, to dielectric surfaces;
> single or triple bond axles;
> substituted aromatic ring rotor comprising two or more substituents with opposite charges, wherein said substituents with opposite charges give the molecule a large dipole having the previous structure, where X' is a positively charged substituent and Y' is a negatively charged substituent.

Sauvage describes construction of interlocking ring structures (catenanes) and rings surrounding molecular "strings" (rotaxanes).

It is believed that the statement regarding bearings in Sauvage should read "metal-to-π-face bond bearings" to correspond to claim 5 of the present invention. It is not seen where the structures described in Sauvage show metal-to-π-face bond bearings. The bearing in the present invention connects the axle and rotor

portion (claim 4). No structures in Sauvage contain an axle and rotor chemically bonded, and no structures in Sauvage include a bearing.

The Office Action stated Sauvage teaches "covalently attached bases, which can be carbon or silicon atoms, to dielectric surfaces." No specific portion of the Sauvage reference is cited to support this statement, and guidance as to where this structure is found in Sauvage is respectfully requested. No surfaces are shown or described in Sauvage. All structures shown and described in Sauvage are free-floating in solution.

The Office Action stated Sauvage teaches single or triple bond axles. Again, it is not clear which portion of the Sauvage reference is being referred to. As defined in the present invention, axles are "rigid enough to prevent undesired motions that interfere with the desired operation" (page 3, lines 10-11). There are no structures corresponding to the axles of the present invention in the Sauvage reference.

The Office Action stated Sauvage discloses a "substituted aromatic ring rotor comprising two or more substituents with opposite charges, wherein said substituents with opposite charges give the molecule a large dipole having the previous structure, where X' is a positively charged substituent and Y' is a negatively charged substituent." Again, it is unclear where in the reference the Examiner is referring. As defined in the present invention, the rotor portion has a dipole moment and is attached to the axle (page 2, line 6). The rotor portion has a sufficient dipole moment to cause rotation of the rotor portion in an alternating electric field or upon application of another suitable stimulus (page 3, lines 25-27). The only structures in Sauvage that contain a dipole are the "strings" shown in Figure 2c. These "string" structures do not fall within the definition of rotor portions in the present invention because they are not attached to an axle and do not rotate in an alternating or rotating electric field. In addition, it is not seen

where in Sauvage a substituted aromatic ring rotor comprising two or more substituents with opposite charges is found.

The Office Action states "it would have been obvious to one skilled in the art at the time the invention was made to use the transition metal-containing rotaxanes and catenanes disclosed by Sauvage on a small-scale two-dimensional pointing motor having the characteristics disclosed by Bederson et al. for the purpose of constructing molecular machines and motors." A prima facie case of obviousness is not made in this case because there is no suggestion or motivation in the references themselves to combine the teachings or modify the references. It is unclear how the structures of Sauvage could be physically combined with the structures of Bederson. Bederson discloses a macroscopic device on the size scale of inches that moves in two dimensions. Sauvage describes molecular structures. No combination of the two references is possible because the references are directed to entirely different structures. Therefore, there is no expectation of success, certainly not a reasonable expectation of success, in combining reference teachings to obtain the present invention. As discussed above, the structures in Sauvage and Bederson do not correspond to the molecular dipolar rotors of the present invention. In addition, one of ordinary skill in the art would not be motivated to combine the teachings of Sauvage with Bederson, since macroscopic motors and molecular structures are clearly nonanalogous art. Therefore, a prima facie case of obviousness is not made because all claim limitations are not taught or suggested by the references.

In view of the above arguments, it is submitted that claims 5-10, 12-17 are not obvious over Bederson in view of Sauvage. Reconsideration and withdrawal of the rejection is respectfully requested.

CONCLUSION

In view of the above arguments and amendments, it is believed all rejections are overcome. Reconsideration and withdrawal of the rejections is

respectfully requested. If there are any issues remaining to passage of the case to issuance, the Examiner is respectfully requested to telephone the undersigned.

It is believed that the present submission does not require the payment of any fees. If this is incorrect however, please charge any fees required, including any extensions of time required, to Deposit Account No. 07-1969.

Respectfully submitted,

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1. (Once amended) A molecular dipolar rotor comprising:

a base;

an axle connected to said base and oriented substantially perpendicular to said base;

a rotor portion connected to said axle and having an electric dipole moment.

3. (Once amended) The dipolar rotor of claim 2, wherein the electric dipole moment of the rotor portion is greater than [about] 2[D]debye.

11. (Once amended) The dipolar rotor of claim 1, wherein said axle is a transition metal atom.

20. (Once amended) The device of claim 19, wherein said rotor portion of said dipolar rotor rotates upon excitation by an alternating electric field, producing electric current by the alternating motion of the electric dipole of the rotor portion of said dipolar rotor.